DEVELOPMENT PLAN FOR A DIVERSION INTO THE MAUREPAS SWAMP

Water Quality and Hydrologic Modeling Components

FINAL REPORT

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EXECUTIVE SUMMARY

Design is proceeding on a project to divert up to 2,500 cubic feet per second (cfs) of Mississippi river water into the Maurepas swamp, an almost permanently flooded estuarine cypress-tupelo (*Taxodium distichum – Nyssa aquatica*) forest south of Lake Maurepas in Louisiana. Baseline hydrologic and water quality information acquired during normal rainfall years was compared with similar data acquired during the drought of 2000. N:P ratios of 16:1 and greater, higher than the Redfield ratio threshold, were found only in samples from the Amite and Blind Rivers that receive runoff from developed areas. Si:N ratios never fell below 1:1. Low N:P and high Si:N ratios indicate that the Maurepas basin is almost always nitrogen limited and will respond to additional river-derived nitrogen through increased plant production, particularly for algae and floating vegetation, even if other nutrients are not increased.

Hydrodynamic and water quality models simulated up to three months continuously, but were then linked to longer horizon ecological algorithms to answer questions about nutrient uptake and the likely response of the forest community to diversions operated at maximum discharges of 500, 1,500 and 2,500 cfs (14, 42 and 71 m^3 s^{-1}). Light Imaging Detection And Ranging (LIDAR) data acquired in 1999 was used to construct the topography of the receiving swamp that ranges in elevation between 1.0 and 1.8 ft (NAVD88), and averages 1.15 ft. The mean tide elevation, in contrast, is 1.5 ft, meaning that the swamp is sinking relative to mean sea level so that much of the forest is now permanently inundated.

TABS finite-element hydrodynamic and water quality models predicted that water levels would be raised by less than 0.25 ft under discharge scenarios ranging from 500 to 2,500 cfs and that flows were fully developed in less than one month.

A 2,500 cfs diversion reduced Lake Maurepas salinity by 30 percent after only one month, showing one important benefit to a swamp forest that experienced salinities greater than 5 ppt in fall 2000.

The simulated diversion, studied using a tracer approach, expanded radially and showed little distortion by topography or channels. River water was introduced with an initial nitrate concentration of 1.5 ppm. The model predicted that 99 percent of all nitrate introduced in the 500 cfs diversion would be retained or removed before it reached the nearest open water boundary. Reduction decreased to 90 percent for a 1,500 cfs diversion, and to 86 percent for a 2,500 cfs discharge. Nitrate loadings in the swamp cells adjacent to Hope Canal range from 0.1 to 0.5 g m^{-2} d^{-1} (37 to 183 g m^{-2} y^{-1}), comparable to rates measured in the Atchafalaya River estuarine complex (Lane et al. 2002) and in experimental wetlands along the Olentangy River, Ohio (Spieles and Mitsch 2000, Mitsch et al. 2001).

Mean nitrate concentration for river water reaching Blind River or the Lake is predicted to range from 0.05 to 0.15 to 0.19 m g-N L^{-1}, respectively, for 500, 1,500 and 2,500 cfs diversions. The value for a 1,500 cfs diversion is higher than concentrations measured in 78 percent of samples acquired during the baseline period, but is within one standard deviation of the mean observed in 2002-2003.

The mean exit concentration predicted for a 2,500 cfs diversion is greater than values measured in 96 percent of all samples collected, and is slightly more than one standard deviation above the mean. This analysis supports the earlier finding that a 1,500 cfs diversion will provide a significant nutrient infusion to more than 10,000 ha of nutrient deprived swamp forest, about half of the swamp south of the Lake, while reducing transiting nitrate by 90 percent to background levels.

The hydrodynamic and water quality models are too computationally intensive to continuously simulate more than a few months in the prototype. Such models cannot directly drive an ecological model for a period of 50 to 200 years, the appropriate time frame over which forest evolution should be evaluated. A hybrid modeling approach, SWAMPSUSTAIN, was developed to bridge the gap between the hydrodynamic model and a fully functional Individual Oriented Model (IOM). SWAMPSUSTAIN calculates the years necessary at a given discharge schedule (scenario) for the swamp in each cell to reach 0.4 ft above mean sea level, the target elevation for sustainability. SWAMPSUSTAIN predicts that between 2,000 and 4,000 ha of the Maurepas swamp can be restored to sustainability within 50 years if average yearly diversion discharges greater than 1,000 cfs are initiated. This leaves a substantial portion of the project area that will benefit from salinity control and nutrient addition, but in which the forest will not be restored to sustainability without additional restoration efforts. Restoration program planners can use this information to build the case for (1) adding additional Mississippi River diversions up or downstream, and (2) augmenting the diversion with other restoration efforts in the project area.

Dredging sediments from Lake Maurepas and pumping them into the swamp, for example, could quickly create additional islands of sustainable wetlands outside the area of swamp that can be restored by the proposed diversion alone.